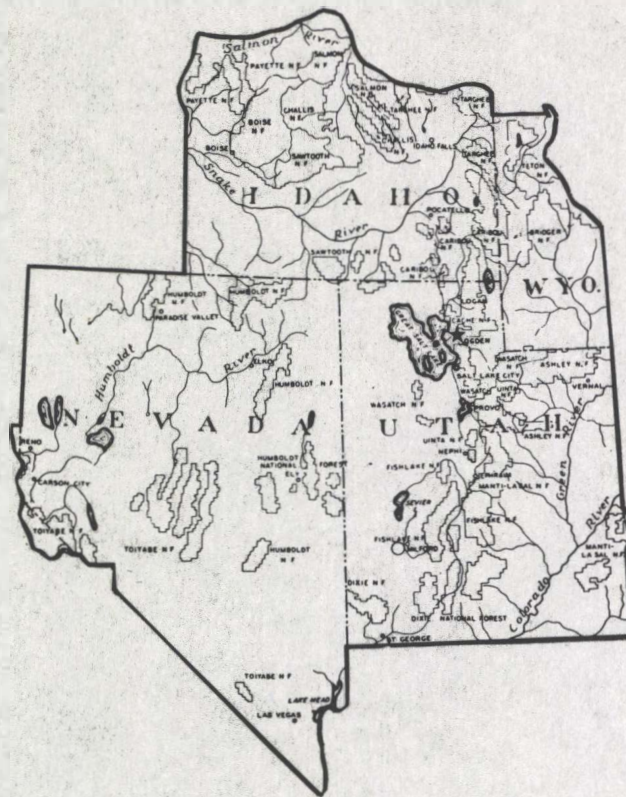


SPRUCE BUDWORM INFESTATIONS

FOREST SERVICE REGION 4

November 1964



DIVISION OF TIMBER MANAGEMENT

Forest Service
U. S. Department of Agriculture
Ogden, Utah

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INTRODUCTION

The spruce budworm, Choristoneura fumiferana (Clem.), occurs throughout fir stands of the United States and Canada. It is believed to be indigenous to the West but was not recorded as an important pest until 1923, at which time two outbreaks were reported in separate areas in Idaho.

In U. S. Forest Service, Region Four, the spruce budworm feeds on Douglas-fir, Engelmann spruce, and the true firs. Previous outbreaks have been most serious on the National Forests of central-southern Idaho. The first control project in the Region against this pest was carried on from 1955 through 1957. Altogether, over 2.2 million acres were sprayed. The present epidemic in southern Idaho has been active since 1958 and covers some of the same area infested from 1951 through 1957. In 1963, suppressive action was initiated against this outbreak by spraying slightly more than 200,000 acres with DDT. In 1964, 525,000 acres were treated by aerial application of DDT. In both years the dosage rates varied from $\frac{1}{2}$ to 1 pound of DDT per acre and the insecticide was applied by fixed-wing aircraft and helicopter.

This year small, localized epidemic infestations of the budworm were detected on the Fishlake National Forest in southern Utah. In the past the spruce budworm has not been considered a primary pest in the coniferous forests of Utah.

METHODS

A combination of air and ground techniques was used to gather evaluation data on the present spruce budworm situation. Mapping the infestation boundaries and delineation of broad classes of current damage was accomplished by aerial surveys. The groundwork involved examination of larval populations, pupal case counts, and an egg mass survey. The sequential plan developed by Cole ^{1/} was used as a guide in surveying larval population. Pupal density data were collected by following Terrell's ^{2/} sequential table procedure which categorizes expected damage into four classes. The egg mass survey procedures were adopted from suggestions and findings of Carolin and Coulter. ^{3/}

One thousand square inches of foliage were used as the sampling unit for the egg mass survey. Each sample was put into a separate 50 pound flour sack. At least five samples were collected from each sampling point. The bags of foliage were picked up twice weekly and transported to Ogden. All egg mass counts were made in the Region's laboratory at Ogden, Utah, under the direct supervision of an experienced laboratory technician. Estimation of eggs per mass was obtained by using tables prepared by Bean ^{4/} and Terrell ^{2/} with some adaptations. An egg mass adjustment was made to compensate for variations in the numbers of eggs per mass. The same system was used successfully in 1962 and again in 1963 to predict the succeeding year's damage.

Spider mites have caused serious injury to conifers following some spruce budworm spray projects. For this reason spider mite populations on Douglas-fir branches were sampled by the use of a mite brushing machine.

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- ^{1/} Walter E. Cole, Sequential Sampling in Spruce Budworm Control Projects, Forest Science, Volume 6, Number 1, March 1960.
- ^{2/} Tom T. Terrell, Techniques of Spruce Budworm Surveys in the Northern Rocky Mountain Region, 14 pp., 1959 Progress Report. U. S. Department of Agriculture, Intermountain Forest and Range Experiment Station, July 1960.
- ^{3/} V. M. Carolin and W. K. Coulter, Research Findings Relative to the Biological Evaluation of Spruce Budworm Infestations in Oregon, 1-39 pp. U. S. Department of Agriculture, Pacific Northwest Forest and Range Experiment Station, 1959.
- ^{4/} James L. Bean, A Method for Estimating the Number of Spruce Budworm Eggs per Egg Mass, Journal of Economic Entomology, Vol. 54, No. 5, p. 1064, October 1961.

CURRENT CONDITIONS

In 1964 nearly two and three-tenths million acres were defoliated to an intensity visible from the air. One and six-tenths million acres were reported as having suffered visible defoliation in 1963. Of the total acreage presently infested, 60 percent was heavily defoliated compared to the same percentage in 1963 and 48 percent in 1962.

The following table gives a comparison of the acreage by damage classes from 1960 through 1964 for the southern Idaho infestations:

Damage Class in Acres				
Year	Light	Medium	Heavy	Total
1960	297,000	80,000	19,000	396,000
1961	643,000	229,000	553,000	1,425,000
1962	480,000	373,000	788,000	1,641,000
1963	357,760	276,550	988,788	1,623,098
1964	266,000	658,000	1,352,000	2,276,000

Slightly over 525,000 acres of the 1964 infestation were sprayed this year.

In this report the three damage classes are defined by "estimated percent of current foliage destroyed," and are as follows:

Light - Any defoliation visible from the air, usually between 20 and 50 percent.

Medium - 50 to 75 percent defoliation.

Heavy - Over 75 percent defoliation.

Four distinct infestations are discussed under the following headings: Salmon River infestation; Targhee National Forest infestation; Sawtooth National Forest infestation; and the new outbreak affecting about 20,000 acres on the Fishlake National Forest in Utah.

Salmon River Infestation

The Salmon River infestation covers parts of the Salmon, Challis, Payette, and Boise National Forests. It occurs along the main Salmon River Drainage below Dillinger Creek in the Idaho Primitive Area, upriver nearly to Challis, Idaho. In addition, the main side drainages (Middle Fork, Panther Creek, Lemhi River, and North Fork) are infested. There are also several small spot infestations. (See map.)

Acreage by damage class is given in the following table:

1964 Salmon River Infestation

Area	Light	Medium	Heavy	Total
Outside Primitive Area				
Salmon N. F.	64,000	320,000	958,000	1,342,000*
Challis N. F.	79,000	132,000	243,000	454,000
**Idaho Primitive Area	63,000	150,000	146,000	359,000
Totals	206,000	602,000	1,347,000	2,155,000

* Includes 475,000 acres of "heavy" and 125,000 acres of "medium" class damage within the 1964 control boundaries.

** Includes portions of the Salmon, Payette, Challis, and Boise National Forests.

The 1964 infestation covers 2,155,000 acres which is a sizeable increase over the 1963 acreage of 1,312,000 acres. About 359,000 acres of the total are in the Idaho Primitive Area and 600,000 acres are within the 1964 control boundaries.

The 1964 spruce budworm spray program included all the infested areas north of the main Salmon River, and the Panther Creek Drainage. (See map.) Within the control boundaries an untreated acreage totaling 75,000 acres was left along streams to minimize possible adverse effects to fish and fish food organisms. A one-half pound dosage was applied to 40,000 acres along a strip between the one pound concentrations and the unsprayed stream sides. The remaining 485,000 acres were sprayed with one pound per acre. Satisfactory control was achieved on the area sprayed with one pound DDT per acre. However, 23 percent of the area sprayed with the $\frac{1}{2}$ pound dosage was assessed as unsatisfactory. The egg mass survey also reflects the reduction of budworm population within the control area. Separate samples were taken within the one pound, one-half pound, and no-spray zones. Egg mass density averaged 2.8 per 1000 square inches of foliage sampled in the area sprayed with one pound of DDT per acre. Defoliation in this zone is expected to be 15 percent or less next year. In the area sprayed at the rate of one-half pound DDT per acre, egg mass density averaged 3.5 per 1000 square inches of foliage. The expected defoliation in this zone in 1965 is 15-25 percent. In the untreated protective zones along

streams, the samples averaged 5.1 egg masses per 1000 square inches of foliage. Defoliation in the untreated zones is expected to average between 25-50 percent. There was, however, considerable variation in egg mass density in the untreated zone. Therefore, intensity of defoliation is expected to vary considerably in the untreated zone.

No biological evaluations or egg mass surveys were made in the Idaho Primitive Area.

Outside the Primitive Area 955,000 infested acres remained untreated in 1964. It is expected that next year's defoliation will exceed 90 percent on about 45 percent of this area or 430,000 acres. Defoliation should range between 51-90 percent on another 45 percent, and on the remaining 10 percent of the area defoliation will probably be less than 50 percent.

Spider mites were present in relatively large numbers in all areas of the budworm infestation sampled. The fall population density averaged 12 and ranged from 1.0 to 32.0 mites per 100 square inches of foliage. With the resident population of spider mites at a high level, it is quite possible the 1965 mite population may increase sharply in the area sprayed this year.

A summary of the evaluation data is shown in the following tables. In each table the last column is a reflection of the entomologist's opinion based upon egg mass and pupal density data tempered by on-the-ground interpretation. This method has been used for prediction purposes for the last three years and has proved to be more reliable than prediction based solely on egg mass density.

SALMON NATIONAL FOREST
1964 Spruce Budworm Evaluation

Area Treated in 1964
Salmon River

Sample Area	1964	1964	Adjusted Mean		1964 Damage Level	
	Damage Level	Pupal Class	No. 1000	Egg Masses Sq. In.	Egg Mass Prediction	Expected
Colson Creek			5.6		25-50%	25-50%
Dahlonga Creek	50-75%	I	3.0		15-25%	15-25%
Carmen Creek	75-90%	II	2.5		<15%	15-25%
4th of July Creek	90%	II	3.2		15-25%	15-25%
Twin Creek Campground	--	--	3.9		15-25%	15-25%
Panther Creek	--	--	2.2		<15%	<15%
Blackbird Creek	50-75%	II	3.9		15-25%	15-25%
Napias Creek	25-50%	I	1.4		<15%	25-50%
Porphyry Creek	25-50%	II	2.8		<15%	15-25%
Granite Creek	50-75%	I	1.4		<15%	15-25%
Moyer Creek	75-90%	IV	5.6		25-50%	51-90%
Meyers Cove	75-90%	II	7.7		25-50%	51-90%
Yellowjacket	50-75%	II	2.5		<15%	25-50%
Rabbits Foot Mine	25-50%	I	.4		<15%	<15%
Indian Creek	50-75%	II	12.1		51-90%	51-90%

SALMON NATIONAL FOREST
1964 Spruce Budworm Evaluation
(Outside 1964 Project Area)

Main Salmon River Area

Sample Area	1964	1964	Adjusted Mean No. Egg Masses 1000 Sq. In.	1964 Damage Level	
	Damage Level	Pupal Class		Egg Mass Prediction	Expected
Deriar Creek	--	--	27.3	90-100%	90-100%
Williams Creek	50-75%	II	8.4	25-50%	51-90%
Poison Creek	50-75%	III	6.7	25-50%	51-90%

Lemhi River Area

Sample Area	1964	1964	Adjusted Mean No. Egg Masses 1000 Sq. In.	1964 Damage Level	
	Damage Level	Pupal Class		Egg Mass Prediction	Expected
Basin Creek	--	III	--	--	90-100%
Timber Creek	> 90%	IV	20.2	90-100%	90-100%
Agency Creek	--	III	7.7	25-50%	51-90%
McDevitt Creek	> 90%	III	36.7	90-100%	90-100%
Cow Creek	25-50%	II	4.2	15-25%	25-50%
Hayden Creek	--	--	14.2	51-90%	51-90%

CHALLIS NATIONAL FOREST
1964 Spruce Budworm Evaluation

Sample Area	1964	1964	Adjusted Mean No. Egg Masses 1000 Sq. In.	1964 Damage Level	
	Damage Level	Pupal Class		Egg Mass Prediction	Expected
Challis Creek	50-75%	III	5.3	25-50%	51-90%
Morse Creek	75-90%	III	13.7	51-90%	90-100%

Samples collected from six areas within the spray project boundaries contained parasitized egg masses. Five out of six of the collections containing parasitized eggs were from nonsprayed areas along the streams; the other was in an area sprayed with one-half pound of DDT per acre. Four of the collections with egg parasites were located in three widely scattered locations north of the main Salmon River. Two collections were from units just across Panther Creek from each other. On the six areas containing some parasitism, the number of egg masses with parasitized eggs ranged from 11 to 100 percent. The egg parasite was identified as Trichogramma minutum Riley.

In summary, the conditions on the Salmon River infestation are as follows: Nearly one million acres of the present infestation have been subjected to repeated defoliation since 1961. On considerably over one-half of this area, defoliation has exceeded 90 percent for at least the last three years. Tree mortality has occurred at an accelerated rate over the last three years and is now substantial in areas which have received repeated heavy defoliation. The 1964 spray project materially reduced the budworm population on 600,000 acres. However, on the remaining untreated 955,000 acres outside the Idaho Primitive Area the epidemic tendencies of the spruce budworm persist and damage to next year's growth should be equal or greater than that experienced this year.

Targhee National Forest

In 1963 slightly over 200,000 acres of budworm infestation on the Targhee National Forest were included in the Region's budworm control project. Since spray is applied after feeding occurs, the spray program did not materially reduce the damage caused by the 1963 populations. However, as measured by larval mortality, excellent control was obtained; and, the results of the 1963 egg mass survey also reflected a reduction of budworm population. It was predicted that on most of the area treated in 1963 defoliation would be less than 25 percent in 1964. Damage evaluation made in 1964 showed all but one unit was defoliated to the level predicted in 1963. The exception was West Camas Creek Unit where defoliation was considerably lower than expected.

Predictions based on the 1964 spruce budworm egg mass and pupal density surveys indicate that on over 85 percent of the area treated in 1963, the 1965 defoliation should be less than 25 percent. Only 6 percent of the area should receive defoliation of over 50 percent.

Visible defoliation was detected in three new areas this year. One is located on the west side of Henry's Lake, in the Dillon Creek area where trees on 3,600 acres were lightly defoliated, and another on the northeast slopes of Sawtelle Peak where an area of 1,800 acres also show light defoliation. The third area is on the extreme western edge of the Targhee National Forest between Hahn and Key Spring.

Defoliation covered a total of 10,480 acres, 2,280 of which were moderately defoliated, with the remainder barely visible from the air. This infestation is actually an extension of the Lemhi River portion of the Salmon River infestation. In all the new areas next year's defoliation is expected to equal or exceed that occurring this year.

Spider mite populations built up on most areas treated in 1963. Damage was severe enough in a few areas to cause a general reddening of the foliage, readily visible from the air. The areas most seriously affected by the spider mites were West Camas Creek, Bear Gulch, Cottonwood Creek, West Dry Creek, and Willow Creek. Measurements indicate high mite populations are likely to occur again next year in most of the 1963 treated areas. Mite population densities ranged from 3.2 to 101.0 per 100 square inches of foliage with an overall average of 25.0. The areas with the heaviest fall mite populations include all areas with heavy mite damage this year except West Dry Creek. In addition, heavy mite populations were recorded in Picnic Hollow, Yale Creek, Taylor Creek and Snider Creek.

Considering the Targhee National Forest infestation as a whole, control action next year does not seem advisable. However, some budworm population is still present throughout the area treated in 1963, and there are three new spots of infestation where the population may increase. Subsequent evaluations will provide the basic criteria to determine if and when additional control action may be necessary.

TARGHEE NATIONAL FOREST
1964 Spruce Budworm Evaluation

Sample Area	1964	1964	Adjusted Mean No. Egg Masses 1000 Sq. In.	1964 Damage Level	
	Damage Level	Pupal Class		Egg Mass Prediction	Expected
Twin Creek (Sevin Test)	25-50%	I	.7	<15%	15-25%
Targhee Creek (Sevin Test)	< 15%	I	0.0	<15%	<15%
Howard Creek (Sevin Test)	25-50%	II	.1	<15%	15-25%
Yale Creek	< 15%	-	0.0	<15%	<15%
Willow Creek	25-50%	I	.3	<15%	15-25%
Snider Creek	< 25%	I	0.0	<15%	<15%
Taylor Creek	25-50%	I	.3	<15%	<15%
Dry Creek	25-50%	I	0.0	<15%	15-25%
Cottonwood Creek	25-50%	I	0.0	<15%	<15%
West Camas Creek	51-90%	I	.2	<15%	<15%
Bear Gulch	< 25%	I	.3	<15%	<15%
West Rattlesnake Creek	25-50%	II	.1	<15%	25-50%
Dairy Creek	25%	II	1.3	<15%	51-90%
Picnic Hollow	< 25%	I	.5	<15%	<15%
Pleasant Valley Creek	< 25%	I	1.5	<15%	<15%
Gillan Creek (Not sprayed)	25-50%	III	.2	<15%	25-50%

Sawtooth National Forest Infestation

The Sawtooth National Forest infestation in the South Fork of the Boise River and Big and Little Smokey Creeks has been in existence for nearly ten years. During this period there have been several rather sudden population declines. On two occasions the population reductions took place when the budworm was in the moth stage. The reductions were caused by torrential rainstorms that drowned a high proportion of the moths before the eggs were deposited.

From 1961 through 1963 there was a general increase in the acreage infested and the intensity of damage caused by the spruce budworm on the Sawtooth National Forest. The 1964 aerial survey recorded a slight reduction in total area with current damage visible from the air. In addition, there was a marked reduction in the acres that were heavily defoliated. The following table shows the acreage by damage level as seen from the air for the last four years.

SAWTOOTH NATIONAL FOREST

Year	Light	Medium	Heavy	Total
1961	5,000	3,000	5,000	13,000
1962	4,000	10,000	27,000	41,000
1963	14,720	25,440	20,000	60,160
1964	32,000	21,000	1,000	54,000

It is predicted that the intensity of defoliation will be between 51-90 percent on about 60 percent of the area presently infested. On the remaining 40 percent of the area, defoliation should range between 25 and 50 percent of the current year's growth. Prediction for individual areas is given in the following table. The mite populations appear to be at a low level in the budworm infested areas of the Sawtooth National Forest.

SAWTOOTH NATIONAL FOREST
1964 Spruce Budworm Evaluation

Sample Area	1964	1964	Adjusted Mean		1964 Damage Level	
	Damage Level	Pupal Class	No. Egg Masses 1000 Sq. In		Egg Mass Prediction	Expected
Couch Summit	50-75%	III	3.5		15-25%	51-90%
Bounds Creek	50-75%	II	10.6		51-90%	51-90%
Boardman Creek	75-90%	III	10.4		51-90%	51-90%
Big Smokey Creek	75%	II	4.9		15-25%	25-50%
Fleck Summit (North)	90%	III	8.0		25-50%	51-90%
Fleck Summit (South)	--	--	7.0		25-50%	25-50%
Lick Creek	--	--	8.5		25-50%	25-50%

Fishlake National Forest

On the Fishlake National Forest in southern Utah the spruce budworm is now epidemic in two widely separated areas. One small outbreak designated as the Thousand Lake Mountain infestation, located approximately one mile north of the Elkhorn Ranger Station in the southeast portion of the Fishlake National Forest was detected last August. The infestation covers about 500 acres of Douglas-fir, Engelmann spruce and true fir timber. There was no indication of previous defoliation by the spruce budworm in this area. Defoliation of 1964 growth varied from 50 to 75 percent. Pupal density fell within Class III and there was an average of 12.2 egg masses per 1000 square inches of foliage. This data indicate defoliation of next year's growth should range between 51 to 90 percent.

To our knowledge, this is the first verified account of an epidemic spruce budworm infestation in Utah.

The other outbreak is located in the extreme southwest corner of the Fishlake National Forest just east of Beaver, Utah. This infestation is approximately 70 air miles west of the Thousand Lake Mountain infestation and is separated by large open valleys.

Defoliation visible from the air covered 19,500 acres in the heads of Birch and South Creeks. National Forest personnel detected an increase in budworm activity in the South Fork of the Beaver River and in the South Fork of North Creek. Both of these areas are north of where damage was visible from the air. It is therefore quite possible the total area infested with budworm may be two or more times as large as that seen from the air. Unfortunately, this infestation was detected too late in the season to evaluate its potential.

FISHLAKE NATIONAL FOREST 1964 Spruce Budworm Evaluation

Sample Area	1964	1964	Adjusted Mean	1964 Damage Level	
	Damage Level	Pupal Class	No. Egg Masses 1000 Sq. In.	Egg Mass Prediction	Expected
Thousand Lake Mountain	50-75%	III	12.2	51-90%	51-90%
Beaver Area	25-50%	--	--	--	--

DISCUSSION AND SUMMARY

Nearly 2.3 million acres of timber were defoliated by the spruce budworm this year in Region Four. Of this total 20,000 acres are in new infestations on the Fishlake National Forest in Utah. Six hundred thousand acres of infestation are within the area treated this year by aerial application of DDT. Slightly more than 200,000 acres were treated in 1963. The present infestation covers 359,000 acres of timberland in the Idaho Primitive Area. One and one-tenth million acres are located in southern Idaho outside the Primitive Area and have not been treated within the last seven years.

This year throughout the infestation areas the new growth on Douglas-fir was abnormally long. In many areas the shoots were more than twice the length of those produced in 1962 and 1963. Damage assessment is based upon the percentage of new growth destroyed. Consequently, when growth elongation occurs, the actual damage to the infested trees is not as severe in a given damage class as it is when new growth is short; i.e., defoliation of 50 percent of the foliage on two inches of new growth leaves one inch of unaffected growth, whereas if 50 percent of the foliage of a one-inch shoot is destroyed only one-half inch of foliage per tip remains to sustain life in the tree.

Growth elongation makes aerial assessment of current year damage difficult, with the usual effect being a conservative estimate of damage classes.

Egg mass sampling data implies the surviving budworm population in the 1964 control area varied inversely with the amount of DDT applied. Therefore, in general damage next year will be heaviest in the non-treated protection zones and lightest in areas treated with one pound of DDT per acre.

Egg mass surveys are useful for predicting the next season's defoliation. However, there are many variables and uncertainties that prevent complete reliance on egg mass densities alone. It is important for this reason, that trained entomologists assist in the collection of the foliage samples so that on-the-ground observations can be made. Interpretation and analysis of biological and environmental characteristics supply the evidence to support or supplement the egg mass surveys.

Pupal case density measurements can be obtained readily while assessing the current year's damage. Pupal case densities have proven to be valuable aids in the overall interpretation of the budworm situation.

Experienced laboratory people trained to recognize differences in egg mass and deposition patterns can also supply data helpful in the interpretation of the findings. This year the laboratory technician discovered that for the last three years there has been a close correlation between the age of an infestation and the size and shape of budworm egg masses. In new infestations a majority of the egg masses contain two rows of eggs, but in areas where the budworm remains

epidemic over a period of years, the number of rows of eggs per mass gradually changes until a majority of the egg masses contain three to four rows of eggs. The data upon which this observation is made needs to be subjected to analysis and additional study. If proven valid, knowledge of this phenomenon would aid in evaluations of budworm infestations.

Spider mite density per 100 square inches of foliage was measured; however, at this point, no definite prognostication can be made. Nevertheless, the presence of spider mite populations, especially in damaging numbers such as now occur in the 1963 project area, should serve as a warning that spider mites might become a problem wherever DDT is used to control the spruce budworm. Meaningful damage classes related to population density of spider mites need to be developed. Collection of data that can be used for this purpose can be made in connection with evaluation of spruce budworm populations.

There was a significant increase in spruce budworm egg parasites in several localities within areas sprayed in 1964. Careful evaluation of this phenomenon should be continued to determine if and when these parasites might exert a controlling influence on the spruce budworm population.


RECOMMENDATIONS

Direct control action on all the spruce budworm infestations in southern Idaho except the 1963 and 1964 control project areas is justified from an entomological interpretation. Budworm populations are present within the areas treated in the last two years, but no immediate need for respraying is apparent.

There is little question that all of the budworm population outside the control areas in the Salmon River infestation is epidemic, with a definite trend for increasing. Heavy defoliation over a majority of the infestation has occurred for the last several years causing severe damage to the Douglas-fir stands.

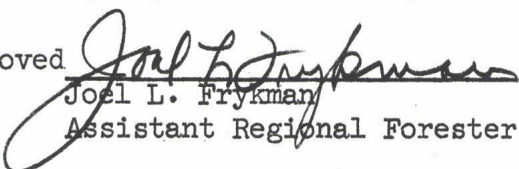
Control action directed against the Sawtooth infestation would be justified on the basis of present population density. However, since this population has declined rapidly on several previous occasions after rapid buildups of three or four years, it seems advisable to wait at least another year before control action is undertaken.

The infestation on the Fishlake National Forest needs more intensive evaluation before recommendation for or against suppressive action can be made.


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Section Chief

Approved 
Paul A. Grossenbach
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Date 12/15/64

Approved 
Joel L. Frykman
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Date 12-16-64

SPRUCE BUDWORM INFESTATIONS REGION FOUR

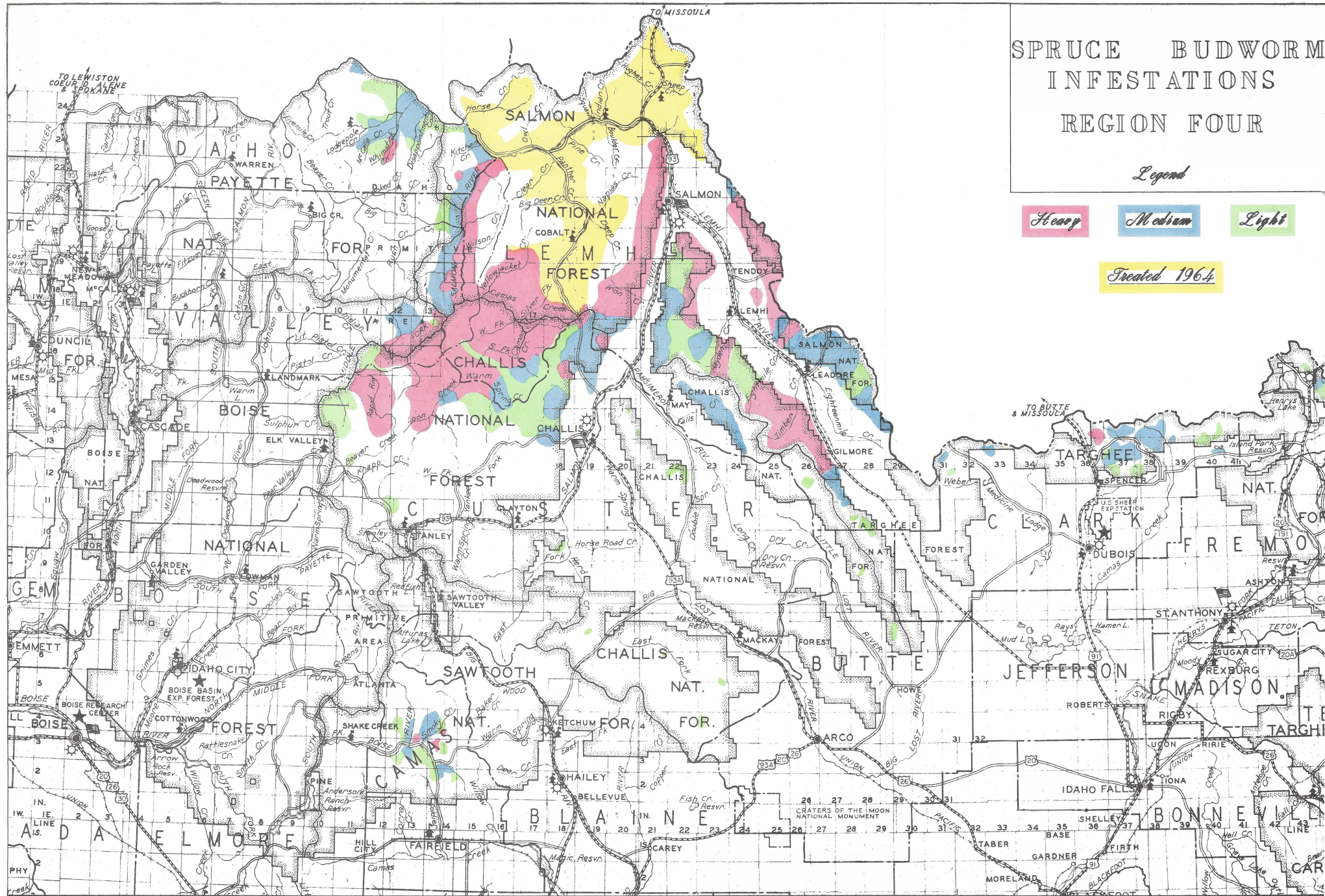
Legend

Heavy

Medium

Light

Treated 1964



1964

FISHLAKE NATIONAL FOREST

Beaver

spruce budworm

1964

